THE CIRCLE SQUARED.

533.e.24.
12

To which is added, a

PROBLEM

To Discover the

LONGITUDE

BOTH AT

LAND and SEA,

BY

Means of a New Instrument which Discovers the Hour of the Day or Night in any *Latitude*, as well as the *Latitude* it self.

a.3949.

By RICHARD LOCKE.

LONDON:

Printed by C. ACKERS in *Great-Swan-Alley*, St. *John's-Street*, for the AUTHOR; and Sold at Mr. *J. Shirley's* in *Dean-Street*, near *Red-Lion-Square*; and by the Bookfellers of *London* and *Westminster*. M,DCC,XXX.

To the Right Honourable
THE
Lords Commissioners,
And to the Honourable
THE
COMMISSIONERS,
Appointed by Act
of Parliament for
Trying and Judging
of all Propolals, Ex-
periments, and Improvements
relating to the Discovery of
the Longitude at Sea, this At-
tempt of Squaring the Circle,
and Discovering the Longi-
tude, is humbly presented by

Your Most Humble, and
Most Obedient Servant,
RICHARD LOCKE.

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COMMISSIONERS,

APPOINTED by Act of Parliament for Trying and Judging of all Proposals, Experiments, and Improvements relating to the Discovery of the Longitude at Sea, this Attempt of Squaring the Circle, and Discovering the Longitude, is humbly presented by

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Most Obedient Servant,

RICHARD LOCKE.

TO THE

RIGHT HONOURABLE

Lords Commissioners,

Lady MARY,

Viscountess Dowager MONTAGUE.

MADAM,

AS it was when I had the Honour to attend on your LADYSHIP, that at my leisure Hours, I discovered this Squaring of the Circle, I could not think of Dedicating it to a Person more Worthy than your Self, and one who delervedly claims the first Fruits of my Labour; which tho' it be but little in Appearance, yet the Uses of it are Universal; for without the Circle nothing can be done in Mathematicks, and for Want of the true Length of the Circumference

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cumference all Parts of Practical Mathematicks must be subject to many Errors, especially Astronomy and Navigation. Tho' not such Speculations, MADAM, but what more tenderly affect the Mind, are the common Employment of your Sex, yet knowing none to give greater Encouragement to any Thing that is publickly Useful than your LADYSHIP, I hope you will accept this as a publick Acknowledgment of all your Favours conferr'd on

Your LADYSHIP'S

Most Obedient, and

Most Humble Servant,

RICHARD LOCKE.

THE CIRCLE SQUARED.

THE Circumference of a Circle is equal to three Times the Diameter; three Times half the Difference between the Diameter and the Side of an equilateral Triangle inſcrib'd, and three Times half the Diſtance between $\frac{1}{8}$ of the Diameter and the ſame equilateral Triangle; or $3AD + 3VD + 3QS$, or to three Times the Diameter, and three Times $\frac{1}{11}$ of the Diameter, and three Times the Diſtance between $\frac{1}{8}$ of the Diameter and the Side of an inſcrib'd equilateral Triangle, or $3AD + 3XD + 3QS$, or it is equal to the Root of the Diameter four Times ſquared, and four Times the Difference between the Diameter and the Side of a Square inſcrib'd.

In order to prove this Aſſertion, inſcribe an Hexagon, equilateral Triangle, *&c.* in a Circle by Prop. 15. Line 4. *Euc.* by the ſame the Side of the Hexagon, is equal to the Radius, from hence 'tis plain, that ſix Times the Radius, or three Times the Diameter, is leſs than the Circumference; make therefore A H equal to A F, A O equal to A B, and A Q equal to A C. The Lines R Q, N O, G H, L M, I call firſt Differences.

A C D being a right Angle make A B T A F I right ones likewiſe, and the Lines Q D, O T, H I, I call ſecond Differences, the firſt Differences ariſe from the Perpendicular to one of the Sides of the Iſoſceles Triangle, and the ſecond from the oppoſite Angle being made a right one; but to make it the clearer I ſhall premiſe theſe three Theorems. (See Fig. IV.)

1. That a Line infinitely decreaſing in a double Proportion, or by Halves, all the Decrements are equal to Half the Line, and a Line decreaſing in a quadruple Proportion all the Decrements are equal to $\frac{1}{4}$, for all the Parts of a Line are equal to the Whole, and all the Halves or Quarters equal to Half or Quarter: For Inſtance, Suppoſe from the Line A B be taken Half as A E, then E B remains equal to E A, and from E B take Half as E C, and C B remains equal to C E, and from C B take away Half as C D, and D B remains equal to D C, *&c. ad in-*

infinitum. So that here is always as much remains as is taken away, and consequently all the Remainders are equal to what is taken away, which is equal to Half the Line. (See Fig. II.)

2. In the Rectangle Triangle E F A, the Side A F being double to A C, F G the Difference between the two Sides, A E and A F is double to C D the Difference between the Sides A B and A C.

The Triangle A C B is homologous to A F E, the Angles at L and F being right and A common; hence A F : A C :: A E : A B, but A F is double to A C, and consequently A E is double to A B, but A E is equal to A G by Construction, and A B equal to A D, wherefore A F : A C :: A G : A D, hence A G is double to A D, take away A F which is double to A C, together with A C, the remainder F G is double to C D, by Prop. 19 Book 5. *Euc.* and Ax. 20. (See Fig. III.)

3. When the Sides and Angles of one Triangle are double to the Sides and Angle of another, the Side oppos'd to the double Angle is four Times as long as the other. Make the Angle E A H double to E A F, and the Side A F double to A C, the Side F E is double to C B; for the Triangles B A C and E A F are homologous, the Angles being equal, wherefore A F : A C :: F E : C B: but A F is double to A C, and consequently F E double to C B, but F H is equal to F E;

hence E H is four Times as long as C B.

In Order therefore to find out a Line equal to the Circumference, it must be done by the decreasing Proportions of the first and second Differences; for 'tis plain, that A B is less than A F + F B by 2 G H, or twice the Difference between A F and A G; and A C is less than A B + B C by 2 N O and A C; or A Q is less than the Diameter by Q D; so that R Q, N O, G H the first Differences decrease in some Proportion, but to find out in what Proportion, we must suppose the Figure made as before directed, by making the second Differences, which arise from the Rectangles A G D, A B T, &c. and we shall find, that the first and second Differences decrease reciprocally as the Lines and Angles do, that is, when they are compared the first with the second in a double Proportion, for the second Differences are all along in a double Proportion to the first, as Q D is double to N O, A D being equal to 2 A O, A Q equal to 2 A N, by Theo. 21.

But that they all decrease in this Manner will appear very plainly from the similarity of the Triangles; for the Triangle R C D is similar to N B T, the Angle A B N being equal to R C R, and N A B equal to R A C upon equal Arches, and the Angles N and R right, consequently the Angle N B A is equal to R C A, but N B T and R C D being

equal

equal Complements to a Rectangle are equal. Again, the Triangle RCQ is similar to NBO, for RQC is equal to NOB, being the Angles of Iſoſceles Triangles whoſe vertical Angles are equal, the Angles at N and R right, conſequently QCD and OBT are ſimilar.

But becauſe in the next Triangle the Angle of the Differences, as BAC, is double to BAF, and the Decrements are to be conſidered on both Sides of GF, becauſe they meaſure both Arches AF + FB, ſuppoſe βG equal to the two firſt Differences, and GI equal to the two ſecond, the Line βI being perpendicular to Fβ from the Point H. The Triangle FβI is ſimilar to NBT; which I prove thus, in the Triangle FAG the Angles FAG and GFA are equal to a right Angle, and ſo in the Triangle NAB the Angles at A and B are equal to a right Angle; but BAN is double to FAG, conſequently NBA is leſs than GFA by GAF, and βFG is equal to FAG being equal to GFI, the Complement of a Rectangle; wherefore βFI is equal to NBT, but the Angle βFG is equal to NBO, being equal to FAG, as will be prov'd afterwards; conſequently the Angle GFI is equal to OBT, for the Angles of the firſt and ſecond Differences are equal; NBO=OBT, becauſe NBO=FAG=½BAN, and BAN is equal to NBT. Wherefore ſince the Angles of theſe Tri-

Triangles are equal the Sides must be homologous, by Prop. 4. L. 6. *Euc.* Hence D Q : Q R :: T O : O N :: I G : G β, hence D Q being a Multiple of N O or = 2 N O, consequently O T must be Multiple of β G or = 4 β G, which I prove thus, N B being ſubtended by the Angle N A B, which is double to the Angle F A G, that ſubtends the Side G F, but the Sides A N and A B wanting ſomething of being double to A G and A F, the Side N B muſt be ſomething leſs than 4 F G, as may be inferr'd from Theo. 30. But the other Sides of the Triangle are in the ſame Proportion, as F β : β G :: B N : N O, and conſequently N O is not equal to 4 β G, but O T being more than N O, and a Multiple of β G muſt be = to 4 β O; but if the Angles had been equal it would have been juſt double, ſo that the Differences, compared one with another, decreaſe as the Angles and Sides do, which is in a double Proportion.

Hence then the firſt Differences R Q, N O, B G, being leſs than in a double Proportion, and the ſecond Differences Q D, O T, G I, more, for Q D : Q R :: T O : O N, and Q D being bigger than Q R, and conſequently O T than O N, but Q D is double to N O, therefore it is not double to O T, ſo that here is a little Difference between R Q and Q D, N O and O T, &c. which decreaſes the ſame as they do, by Prop. 10. Book 5. *Euc.* and

and consequently determines the Excess in one, and Defects in the other; wherefore half Q D + ½ the Difference between R Q, and Q D, are equal to all the descending Differences, as N O, & G, &c. *i. e.* the Diameter A D or A B + B C + V D + ½ the Difference between R Q and Q D, or ½ Q S, are equal to the Arch A B C, and three Times that Line equal to the whole Circumference, which proves the two Positions that were laid down at first.

But that this Line is exactly equal, is plain from the Comparison of the Angles, for the Angle A C R is equal to the Angle A B N, and R C D equal to N B T, as was prov'd before; but G F A is bigger than the Angle N B A by the Angle G A F, as was likewise prov'd before. But then as these Angles increase, the Angles of the Differences decrease, for N B T is greater than G F I by G A F, because G F A and G F I are equal to a Rectangle, consequently as the Angles of the Differences decrease, so the other Angles increase; but it cannot be more than the right Angle, for when the Angle N B A, G F A, &c. is become a right Angle, as it must *ad infinitum*, then the Angles of the Difference vanish, and B T, F I, &c. coincide with the Diameter, so that all the Differences of the Arch, as A F, A K, K F, &c. are just equal to the Line A I subtended by the right Angle A F I, I supposing G H a first Difference

rence, and HI a ſecond Difference, and twice that Line, or $\beta I + AB$ equal to the Arch AB, and $2\beta I + AB + BC$ equal to the Arch ABC; but $2\beta I$ are equal to OT + the Difference between NO and OT = $\frac{1}{2}QD + \frac{1}{2}QS$, for OT is equal to $4\beta G$, but not to 4GI the two ſecond Differences; wherefore OT + the Difference between NO and OT are juſt equal, as is plain from what was before ſaid with reſpect to their Proportions. And if we carry this to the Diameter, by inſcribing the Square AZD, we ſhall find that by the Decreaſing of the Angle of the Differences EZD, and Increaſing of the other as AZE, till it comes to a Rectangle, that the Root of the Diameter four Times ſquared, and four Times the Difference between the Diameter and the Side of an inſcrib'd Square, is juſt equal to the ſame, for the Root of AEq, and the Root of EZq, are equal to once the Diameter, and the Squares together = AZq, which muſt be four Times, becauſe of the four Arches, the Diameter 16 ſquar'd is 256, four Times is 1024, the ſquare Root is 32, and four Times RD is = 16 which added make 48, and four Times RY is equal to 3 +, which added to 48 makes 51 + for AZ is equal to 11 +, and AR = 12, which diſcovers RY, which is the ſame as before.

But

But then there is another Diſpoſition of the Figure which gives another Demonſtration, and which is by other Lines, as NB, FG, &c. for 'tis certain the more theſe Lines ſhorten the nearer they approach to the Circumference, 'till at laſt they coincide with it; now theſe Lines decreaſe in a quadruple Proportion as they are compared one with another, becauſe the Angles and Sides decreaſe double, for BN is near equal to 4FG, becauſe AB is double to AG, and AN near double to AF, and the Angle BAN double to FAG, and FG is near equal to 4KL for the ſame Reaſon, by Theo. 3. But (not to confound the Figure with Lines) ſuppoſe AT were double to AF, which in reality is more, and AB being double to AG, BT would be equal to 4GF, and FI with the ſame Suppoſition equal to 4KL; but BT being equal to 4FG it is not equal to 4FI, and conſequently is too little to meaſure the other Decrements, as KM, &c. this depends upon AT being double to AF; but in reality ABT being a right Angle, AT is more than 2AF, becauſe OT is bigger than NO, otherwiſe it would be leſs, as being only double to GH. Hence then BT includes all the Decrements, becauſe the Angle AFG is bigger than ABN, and ſo they increaſe 'till at laſt they coincide with the Diameter, and become equal to the Rectangle; wherefore $\frac{1}{4}$FG + $\frac{1}{4}$ the Difference

between FG and FI are equal to KL, and all the other Decrements of the Arch AKF, and AB + BC + FG with the whole Difference between FG and FI, equal to the Arch ABC, which is the ſame as was before advanc'd; for FG is equal to VD, being equal to NO, and NO equal to VD, which I prove thus, the Triangle AEF is equal to the Triangle AOB, for the Angle A at the Circumference being upon a double Arch is equal to E at the Center, and both being Iſoſceles the other Angles muſt be equal, and the Sides AE, EF, AB, AO are equal, being Radii of the ſame Circle. Again, the Triangle EAG is equal to ANB, the Angles at A and E, and the Angles at N, and G right, and the Side AE equal to AB, conſequently the two Triangles are equal: Take away therefore EG and AN, and NO remains equal to GF = VD, and the Angle NBO equal to FAG, as was promis'd before to be prov'd; and the Difference between FG and FI in the ſame Proportion as RQ and QD, becauſe the Angle GFI is equal to Half RCD, conſequently the Proportion of the Sides which decreaſe by 4, as GF, muſt be equal to the Proportion of the Sides which decreaſe by 2, as RD or GI, and this confirms what was before advanc'd.

In order therefore to find out the Line QD + QS, ACD being a rightangl'd Triangle,

angle, the Square of the Diameter AD is equal to the Squares of AC + CD, to find AC or AQ, ſquare the Diameter AD, and Half the Diameter CD, ſubſtract the latter from the former, extract the ſquare Root, which Root ſubſtract from the Diameter, and the Remainder is QD; ſubſtract that again from Half the Radius or DR, and the Remainder is QR, which ſubſtract from QD, and the Remainder is the Difference between the firſt and ſecond Differences, as RQ and QD, or QS, Half of which, together with the Diameter, is equal to the Arch ABC, and three Diameters + $3\frac{1}{2}$QS + $3\frac{1}{2}$QD equal to the whole Circumference. And by this we find the Length of any Part of the Circle, for AO + $\frac{1}{2}$OT + Half the Difference between NO and OT are equal to the Arch AB; but this is not ſo eaſily done in Numbers unleſs upon the Diameter.

But I ſhall give one Inſtance of it in Numbers; let the Diameter be 16, or any other Number.

D	16	$\frac{1}{2}$ D	8
	16		8
	97		64
	16		
	256		
	64		
	192		
23	092		
	69		
	23		

So

So that AQ is equal to 13 $\frac{11}{26}$ which ſubſtracted from the Diameter leaves 2 $\frac{15}{26}$ equal to QD, and QS is equal to $\frac{01}{26}$, and Half QD is 1 $\frac{07}{13}$, and Half QS $\frac{01}{52}$, which added to the Diameter makes 17 $\frac{41}{52}$, and multiplied by 3 it is 51 $\frac{123}{52}$, or 51 $\frac{02}{26}$, which is ſomewhat greater than the common Proportions, for 7 : 22 :: 16 : 50 $\frac{2}{7}$; but inſcribing and circumſcribing is ſo uncertain, that it can make nothing againſt this Demonſtration.

Tho' in little Diameters the Difference be ſo inconſiderable, yet in greater it makes a vaſt Difference; as ſuppoſing it to be 100000, according to this Way the Circumference is 320097, and more, and according to the Proportion it is 314285; ſo that here is more than 6000 Parts difference in only 300000, and ſuch vaſt Differences muſt cauſe many Irregularities in all Parts of the Mathematicks, eſpecially in the vaſt Diſtances of the Sun and Stars. I ſubmit this to the Cenſure of the World, and as there is a long Train of Reaſoning, and few can pretend to Infallibility, ſo I ſhall not be too confident; but only ſay, that I know no Fault in it at preſent. But as for the concluding Part, upon the Increaſe of the Angles, 'till they become Rectangles, plainly demonſtrates, that the Proportion does not give the true Circumference, which muſt neceſſarily ſubject Aſtronomy to many Irregularities. And tho' Thouſands of Miles

in the Motion of the Sun, muſt cauſe but little Alteration in its Motion here, yet it muſt make the Calculations and Obſervations vaſtly different, in comparing the Sun and Moon with the fixed Stars, and what makes here in our Inſtruments but one Degree, yet, compared with the fixed Stars, it muſt be vaſtly great. Upon the whole, this Method will ſquare any Curve, by Means of the two Differences in the Iſoſceles Triangle made by the Perpendicular and Rectangle.

A

PROBLEM

In Order to find the LONGITUDE at Sea and Land.

TO find the Longitude, as we do the Latitude of any Place, there is a great Difficulty ariſes, which is chiefly becauſe we have no fixed Points, or regular Motion from *North* to *South*, as we have from *Eaſt* to *Weſt*; but this may be compenſated by the different Motion of two Bodies, when they move in a Circle, the one performing his Revolutions in a conſiderably leſs Time than the other; as it happens in the Sun and Moon, the Moon performing its Revolutions twelve Times or more to the Sun's once, which muſt cauſe a continual Receſſion of the Moon from the Sun; and then, beſides this annual and monthly Motion of the Sun and Moon, they have likewiſe a diurnal Motion round the Earth in 24 Hours, and in this Time the Moon muſt have receded ſeveral Degrees from the Sun, at leaſt 12 or 13. Suppoſe then the Sun and Moon in the oppoſite Meridian to ours to be in conjunction,

junction, by that Time the Sun is come to our Meridian, the Moon muſt have receded to the *Eaſtward* of the Sun more than ſix Degrees; ſo that could we at any Time find by Obſervation the Diſtance of the Moon from the Sun, and at the ſame Time calculate their Diſtances for other Meridians, the Difference of Meridians may eaſily be found. This Notion of the Longitude depends upon the Calculation of the Moon's Parallax, or Longitude and Latitude, for any known Place upon the Earth, and at the ſame by obſerving the Parallax, or Longitude and Latitude from two fixed Stars, which is near the ſame as determining the Longitude by the Eclipſes, by finding by Obſervation and Calculation the different Parts of the Moon's Body, at the ſame Hour in different Meridians, as are obſcured, and theſe different Parts give the Difference of Longitude; but as the Diſtance of the Sun and Moon cannot be obſerv'd, becauſe they ſeldom appear together, therefore it muſt be done by the Stars.

By a new-invented Inſtrument the Diſtance of any Star round the *North* and *South* Pole may be known to the leaſt Time; from the *Zenith* Meridian, in which the Obſervation is made, and conſequently the exact Hour of the Night for that Meridian, the Inſtrument ſhews the Latitude of the Place at the ſame Obſervation; for there being two

fixed

fixed Points in the Heavens, about which the whole Firmament revolves, and tho' there are no Stars yet the Polar Points are known, the *North* Pole-Star being 2d. 24m. distant from the Pole, and the Pole always falling between that Star and the two Pointers in the Bear's Back, by the Instrument is known how far they are past the *Zenith* Meridian, which determines the Place of the Pole; for if the Pointers are in the upper Meridian add 2d. 24m. to the Hight of the Polar-Star, and it gives the Latitude; if in the opposite or lower Subduct 2d. 24m. from the Star, and it gives the same; if they are in Quadrature, the Hight of the Polar-Star is the Latitude, or 1d. 56 distant from the Meridian and subducted, if in the lower and the other Parts may easily be found by the same Method. The same might be done about the *Southern* Pole, by knowing the Declination of the nearest Star, having found the Latitude of the Place, next find the Hour of the Night; suppose the Observation made the 18th of *May*, find by the Instrument how far these two Pointers, or any known Stars, are past from the Meridian, which let be 3od. to the *Westward*, the Place of the Sun is about 7d. 21m. of *Gemini*, which is taken out of Sir *Jonas Moore's* Table; but Calculation would bring it to a greater Exactness; and the Star is in the 25d. 32m. of *Leo*, the Difference is 77d. 53m. which is to

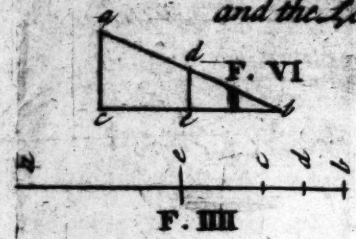
to Time it is 5^h 11^m that they come to the Meridian of that Place, add 30^d which they are pass'd, and turn'd into Time it is two Hours, which makes 7^h 11^m. which is the exact Time of Night. Having thus gain'd the Latitude of the Place, and the Time of the Night, the next Thing is to find out how far the Moon has receded from the Sun since it came from any known Meridian; to do which take the Moon's Hight, or Parallax of Altitude, or take its Longitude and Latitude from two fix'd Stars, for that Latitude, and calculate the same for any other Longitude or Latitude, and by the different Parallax, or Longitude and Latitude the Quantity of the Moon's Recession is known, and consequently the Longitude; as suppose it be found by Observation in the *West-Indies*, that the Moon has fallen back from the Sun 4^d since it pass'd the Meridian of *London*, the Difference of Longitude is easily discover'd; for suppose the Moon recedes 12^d in going 360 (as in reality it does more, but that is easily known by knowing the Moon's Position) then by Proportion 12:360::4:120, consequently it must be 120^d Difference of Longitude. Now the Irregularities in the Moon's Motion are corrected by the Tables, for 'tis but finding the Moon's true Place, as it is done in calculating Eclipses, which commonly agree with Observation, and the Moon's

Place, by Obſervation, may be exactly enough determin'd, which gives its Receſſion ſince it parted from any Meridian, and conſequently the Longitude; we are not always oblig'd to calculate for one Meridian, but as all the noted Places upon Earth are known, as to their Longitude and Latitude, ſo the Calculations may be made for 180d diſtant from the ſuppos'd Place, and then the Moon's Receſſion will be always more than 6d. I propoſe this by Way of Problem; but Time and Experience muſt determine as to the Truth of it in Practice.

F I N I S.

The Circle Squared.

and the Longitude Discover'd



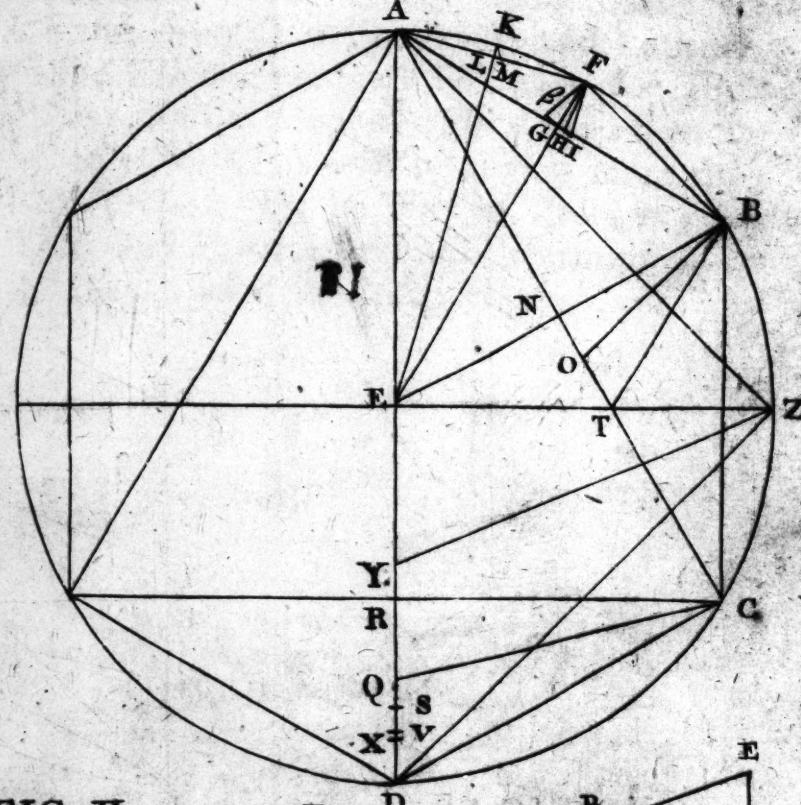


FIG. II.

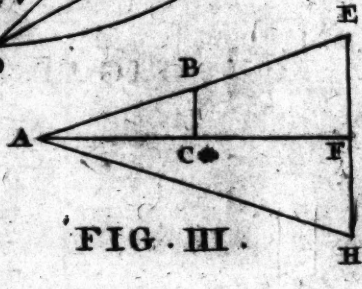


FIG. III.

By Richard Locke.

AN

APPENDIX

TO THE

Circle Squared, &c.

Giving a ſhort DESCRIPTION of the Inſtrument, and a new Method to obſerve the Moon's Place at any Time, to a Minute, which diſcovers the LONGITUDE at Land and Sea.

By *RICHARD LOCKE.*

AN

APPENDIX

TO THE

Circle Squared, &c.

Giving a short DESCRIPTION of the Instrument, and a new Method to observe the Moon's Place at any Time, to a Minute, which discovers the LONGITUDE at Land and Sea.

By RICHARD LOCKE.

AN APPENDIX TO THE *Circle Squared, &c.*

THE Instrument consists of three Movements (it being an universal Dial) the outer Part has a Circle graduated, which is held up by a Ring in the Handle; the Middle Part has half a Circle graduated in the Middle, of which is drawn the Equinoctial Line, with an Index, that slides in a Slit; the last Movement is a double Line of Sines, for all the Circles of Longitude in this Instrument are projected into Sines.

But then in order to make use of the Instrument: The Equinoctial Line in the Middle Part must be plac'd to the Latitude of the Place in the outer Circle, *North* or *South*, and

and the Index to the *North* or *South* Declination of the Sun, Moon, or Stars; the laſt Movement muſt likewiſe be placed to the ſame Latitude *North* or *South* with the Equinoctial Line: And the Shadow from the Index will give the Hour of the Day, if it be the Sun; or if the Moon, or Stars, it will give their Diſtance from the Meridian of Obſervation. But becauſe the Moon or Stars, and ſometimes the Sun, caſt but little or no Shadow, there is a little Sight plac'd upon the Line of Sines, which moves up and down, and which, with the Index, determines their Place by making them ſerve as two Sights.

But the Longitude cannot be determin'd by Obſervation at Sea, unleſs it be by the Receſſion of the Moon, which any one, by Reflection, might eaſily perceive, there being no Motion from *North* to *South*, and all the different Riſings and Settings of the Stars only determining the Latitude. And becauſe the Motion of the Moon, which recedes more than 12 Degrees every Day from the Sun (as was obſerved in the Problem) has not as yet been ſufficiently ſettled, to know her Place by Obſervation: I ſhall therefore lay down a new Method, in order to find her Place by Obſervation, to a Minute, without any of thoſe tedious Equations which are commonly made Uſe of in her Quadratures, and to no Purpoſe. This is eaſily done by only con-

considering the Moon's Motion, which is in a Spiral Line, moving by the Ecliptick. As for instance; Fig. 5.

Let Æ Q be the Equator, E C Ecliptick, L M the Line of the Moon's Motion; suppose therefore L E equal to the Moon's greatest Latitude at that Time, or 5°. 18'; by the Time the Moon has perform'd its Revolution, its Node will have gone back 1°. 30'. or thereabouts, and consequently its Latitude a little diminish'd; so that M C will be less than L E. And thus it continues for 19 Years, until its Latitude coincide with the Ecliptick, and then it increases again towards the *South*. Neither will this Line in any Respect alter the Nature of the Eclipses, for the Interpositions will happen the same, notwithstanding the Moon retains near the same real Latitude. As for Instance, supposing that the Sun be at Æ, the Earth at b, and the Moon at C; the Moon's Latitude, with Respect to the Sun and Earth, will coincide with the Ecliptick, and then will be a total Eclipse. And in Proportion the farther or nearer remov'd from that Point, the Eclipse will be more or less partial, as is plain from the Principles of Vision. The Earth likewise moves in a spiral Circle about 50" North of the Ecliptick, which is the Cause of the Procession of the Equinox, and that she stays longer in the Northern than in the Southern Signs; the same happens with

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Reſpect to the Planets, which will account for all their Irregularities.

But in Order to make a true Obſervation of the Moon's Place, we muſt calculate the Latitude of the Moon when it is in the greateſt Declination of the Ecliptick. As, ſuppoſe the Moon in the firſt Degree of the *Crabb*, or a b, then the Moon's Latitude added to the Declination will give her whole Declination; but after it is turn'd from that Point, we are no longer to mind the Latitude, but only to find the Declination, according to the common Rules of finding the intermediate Declinations of the Sun. 'Tis true there may be a juſt Allowance made for the continual Decreaſe of the Angle of the Line with the Equator; but this will make but little or no Difference in the Obſervation, only obſerving, that in the *South* the greateſt Latitude muſt be ſubtracted from the greateſt Declination, when the Node is *North*, but contrary, when the ſame is *South*; which gives the true Declination of the Moon, as any one may find by Obſervation.

Suppoſing, therefore, an Obſervation be made when the Moon is in the 15d. of the *Lion*, in Order to find the true Declination it may be done by knowing the Moon's greateſt Declination. As for Inſtance;

Let A C be her greateſt Declination at that Time, or equal to 28°. and A B equal to 90, or a Quarter of the Circle; then, becauſe the

the Moon is in 15°. of the fifth Sign, ſubſtract that from 180, or 125 from 180, and there remains 55; then by Proportion, Fig. 6. a b : a c : : d b : d e, or 90 : 28 : : 55 : 17°. 6. which is the exact Declination; as any one may find by obſerving the Moon at that Time in the Meridian.

This Line likewiſe determines the exact Time of the Moon's coming to the Meridian; for if the Moon be aſcending it comes later to the Meridian, than the Point of the Ecliptick does; if deſcending it comes ſooner: And the Difference may eaſily be known by knowing the Moon's Place; which is clear from conſulting the Figure. For ſuppoſe a b the Meridian, 'tis plain that L will come to that Meridian before L, when it is aſcending; but when it is deſcending, L will be paſs'd the Meridian before E, and conſequently later. All which may be eaſily found out by Trigonometry. But in the *Southern* Declination it has the contrary Effect.

In Order therefore to make an Obſervation with the Inſtrument, find the Moon's Longitude and Latitude by Calculation, for ſome little Time before Obſervation, with only the Anomaly, without any other Equations, and it will determine the Moon's Place exactly for Obſervation: Then place the Index to the Moon's Declination, found as before directed, (the other Parts being plac'd to the Latitude of the Place,) and the Sight being

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mov'd up and down, till it falls in with the Index, determines the true Distance of the Moon from the Meridian of Observation. Afterwards place the Index to the Declination of a known Star, and it gives its true Distance from the same Meridian, and consequently the Distance from the Moon to a Minute, if the Observation be justly made. The Star will give the true Hour of the Night in that Meridian, which will adjust the Moon's Motion directly to the Time of Observation, and the Calculation and Observation will agree to a Minute, if the Tables are made for the same Meridian; and in different Meridians it will give the Recession of the Moon, and consequently the different Hour or Meridian; as it has been many Times tried by this Instrument on the same Meridian; but for Want of Encouragement has not been try'd in different ones, unless it be by different Calculations. The Author doubts not, but if he were at Sea, and no Observations made for a considerable Time, if he could but see the Moon and Stars, he would exactly determine the Longitude and Latitude the Ship was in. But

Haud facile emergunt quorum Virtutibus obstat
Res angusta Domi.

F I N I S.